TCC
Nokia

FINAS
Finnish Accreditation Service
T117 (EN ISO/IEC 17025)

HAC RF Emissions Test Report

Test report no.:	Salo_HAC_0743_04	**Date of report:**	2007-10-24
Template version:	3.0	**Number of pages:**	27
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Responsible test engineer:	Ari Orte	**Product contact person:**	Marcus Goeke
Measurements made by:	Ari Orte		
Tested devices:	RM-135		
FCC ID:	QW3RM-135		
Supplement reports:	-		
Testing has been carried out in accordance with:	**ANSI C63.19-2006** American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids		
Documentation:	The documentation of the testing performed on the tested devices is archived for 15 years at TCC Nokia.		
Test results:	**The tested device complies with the requirements in respect of all parameters subject to the test.** The test results and statements relate only to the items tested. The test report shall not be reproduced except in full, without written approval of the laboratory.		

Date and signatures:

For the contents:

Digitally signed by Ari Orte
Date: 2007.10.24 16:05:58 +03'00'

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1. SUMMARY OF HAC RF EMISSION TEST REPORT

1.1 Test Details

Period of test	2007-10-23
SN, HW, SW and DUT numbers of tested device	SN: 004400/99/167518/0, HW: 0400, SW: 1.0649.1.0.13, DUT: 11685
Batteries used in testing	BL-4B, DUT: 11687, 12159, 12160
State of sample	Prototype unit
Notes	AWF = -5 for GSM

1.2 Maximum Results

The maximum measured HAC RF emissions values and categories for electric and magnetic fields are given in section 1.2.1 and 1.2.2 respectively.

1.2.1 Electric field measurements

Band & Mode	Ch / Freq. [MHz]	Limit of E-field max. value in category M3 [V/m]	Maximum E-field value after exclusion [V/m]	Category
GSM850	251 / 848.8	149.6 - 266.1	225.3	M3 (-5dB)
GSM1900	810 / 1909.8	47.3 - 84.1	61.0	M3 (-5dB)

1.2.2 Magnetic field measurements

Band & Mode	Ch / Freq. [MHz]	Limit of H-field max. value in category M3 [A/m]	Maximum H-field value after exclusion [A/m]	Category
GSM850	251 / 848.8	0.45 - 0.80	0.420	M4 (-5dB)
GSM1900	810 / 1909.8	0.14 - 0.25	0.147	M3 (-5dB)

1.2.3 Overall RF emissions category of the tested device

Band & Mode	Combined category (E- and H-fields)	Pass / Fail
GSM850	M3 (-5dB)	Pass
GSM1900	M3 (-5dB)	Pass

1.2.4 Maximum Drift

Maximum drift during measurements	0.24 dB

1.2.5 Measurement Uncertainty

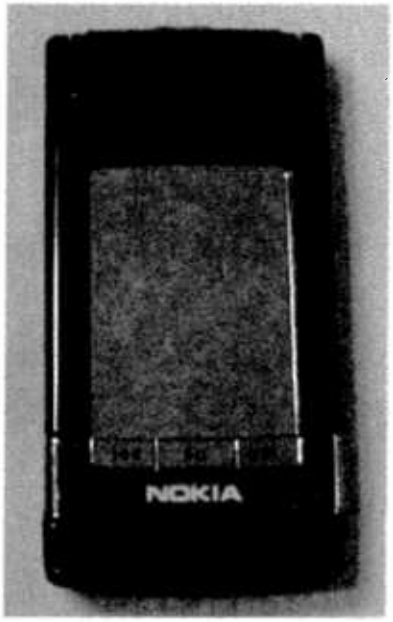
Extended Uncertainty (k=2) 95%, E-field	14.7 %
Extended Uncertainty (k=2) 95%, H-field	10.9 %

2. DESCRIPTION OF THE DEVICE UNDER TEST (DUT)

Modes of Operation	Bands	Modulation Mode	Duty Cycle	Transmitter Frequency Range (MHz)
GSM	850	GMSK	1/8	824 – 849
GSM	1900	GMSK	1/8	1850 – 1910

Outside of USA the transmitter of the device is capable of operating also in 900MHz, 1800MHz and 2100MHz bands, which are not part of this filing.

2.1 Picture of Device



Flip closed


Flip open

3. TEST CONDITIONS

3.1 Temperature and Humidity

Ambient temperature [°C]:	19.1 to 20.2
Ambient humidity [RH %]:	42 to 45

3.2 Test Signal, Frequencies, and Output Power

The transmitter of the device was put into operation by using a call tester. Communications between the device and the call tester were established by air link.

For all tests the device output power was set to maximum power level; a fully charged battery was used for every test sequence.

The measurements were performed on low, middle and high channels.

4. DESCRIPTION OF THE TEST EQUIPMENT

4.1 Measurement system and components

The measurements were performed using an automated near-field scanning system, DASY 4, manufactured by Schmid & Partner Engineering AG (SPEAG) in Switzerland.
The following table lists calibration dates of SPEAG components:

Test Equipment	Serial Number	Calibration Interval	Calibration expiry
DAE V4	555	12 months	2008-03
E-field Probe ER3DV6	2333	12 months	2008-02
H-field Probe H3DV6	6053	12 months	2008-02
Dipole Validation Kit, CD835V3	1004	24 months	2009-02
Dipole Validation Kit, CD1880V3	1003	24 months	2009-02

Additional test equipment used in testing and validation:

Test Equipment	Model	Serial Number	Calibration Interval	Calibration expiry
Signal Generator	SML03	101265	12 months	2008-07
Amplifier	ZHL-42 (SMA)	N072095-S	12 months	2008-07
Power Meter	NRVS	849305/028	12 months	2008-07
Power Sensor	NRV-Z32	839176/020	12 months	2008-07
Radio Communication Tester	CMU 200	101111	12 months	2008-07

4.1.1 Isotropic E-field probe ER3DV6

Construction	One dipole parallel, two dipoles normal to probe axis Built-in shielding against static charges PEEK enclosure material
Frequency	In air 100 MHz to >6 GHz; Linearity: ± 0.2 dB (100 MHz to 3 GHz)
Directivity	± 0.2 dB in air (rotation around probe axis) ± 0.4 dB in air (rotation normal to probe axis)
Dynamic Range	2 V/m to > 1000 V/m; Linearity: ± 0.2 dB
Dimensions	Overall length: 330 mm Tip length: 16 mm Body diameter: 12 mm Tip diameter: 8 mm Distance from probe tip to nearest point of dipole: 1.25 mm
Application	General near-field measurements up to 6 GHz Field component measurements Fast automatic scanning in phantoms

4.1.2 Isotropic H-field probe H3DV6

Construction	Three concentric loop sensors with 3.8 mm loop diameters Resistively loaded detector diodes for linear response Built-in shielding against static charges PEEK enclosure material
Frequency	200 MHz to 3 GHz; Output linearized (absolute accuracy ±6.0%, k=2)
Directivity	± 0.25 dB (spherical isotropy error)
Dynamic Range	10 mA/m to 2 A/m at 1 GHz
Dimensions	Overall length: 330 mm Tip length: 40 mm Body diameter: 12 mm Tip diameter: 6 mm Distance from probe tip to nearest point of dipole: 1.1 mm
Application	General magnetic near-field measurements up to 3 GHz Field component measurements, surface current measurements Measurements in air or liquids, low interaction

4.1.3 Device Holder

The Device Holder and Test Arch are manufactured by Speag (http://www.dasy4.com/hac). Test arch is used for all tests i.e. for both validation testing and device testing. The holder and test arch conforms to the requirements of ANSI C63.19.

The SPEAG device holder (see Section 5.1) was used to position the test device in all tests.

4.2 Validation of the System

The manufacturer calibrates the probes annually. Validation measurements are made regularly using the dipole validation kit. The power level used by manufacturer in dipole calibration is supplied to the dipole antenna. The antenna is scanned at 1.0cm distance between top surface of the dipole and calibration point of the probe.

System Validation, H-field and E-field

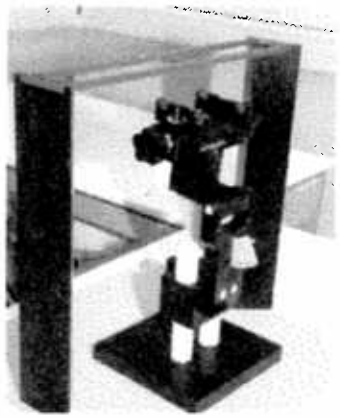
f [MHz]	Description	H-field [A/m]	E-field [V/m]
835	Reference result	0.452	160.0
	± 10% window	0.406 - 0.497	144.0 - 176.0
	2007-10-23	0.474	167.6
1880	Reference result	0.452	128.8
	± 10% window	0.406 - 0.497	115.9 - 141.7
	2007-10-23	0.445	128.6

Plots of the system validation scans are given in Appendix A.

5. DESCRIPTION OF THE TEST PROCEDURE

5.1 Test Arch and Device Holder

The test device was placed in the Device Holder (illustrated below) that is supplied by SPEAG. Using this positioner the tested device is positioned under Test Arch.



Device holder and Test Arch supplied by SPEAG

5.2 Test Positions

5.2.1 Scan area centered at the acoustic output

The device was positioned such that Device Reference plane was touching the bottom of the Test Arch. The scan is centered at the acoustic output by aligning the acoustic output with the intersection of the Test Arch's middle bar and dielectric wire.

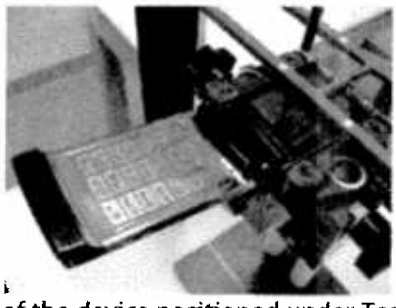


Photo of the device positioned under Test Arch

5.3 Scan Procedures

Near field scans of 5cm x 5cm were used for determination of the field distribution. Measurement plane distance from WD reference plane is 1cm. Scans were performed for both E- and H-field using appropriate probe. DASY software divides detected values into 3 x 3 sub grids as described in the C63.19 standard.

5.4 Scan area centered at the maximum magnetic T-coil coupling

Scanning centered at the maximum magnetic T-coil coupling was not applicable for the tested device.

5.5 Probe Modulation Factor

All raw measurements in DASY4 system are presented as RMS values. The measurement software then applies Probe Modulation Factor (PMF) to convert readings to "slot averaged" peak values as required by C63.19 standard.

Therefore PMF was assessed as described in C63.19 standard along with Speag's Application Note (AN_Hearing_Aid_Compatibility.pdf, section 28.8, "Definition / Determination of the Probe Modulation Factor").

Observed Modulation Factor:

$PMF_{(E)}$ = E-field$_{(CW)}$ / E-field $_{(Modulated)}$

$PMF_{(H)}$ = H-field$_{(CW)}$ / H-field $_{(Modulated)}$

Observed Crest Factor:

$CF_{(E)} = (PMF_{(E)})^2$

$CF_{(H)} = (PMF_{(H)})^2$

Modulation factors, GSM

f [MHz]	p [dBm]	E-field [V/m] Probe SN: 2333		H-field [A/m] Probe SN: 6053		PMF E-field	PMF H-field
		CW	GSM	CW	GSM		
835.0	20	95.6	33.9	0.452	0.173	2.82	2.61
1880.0	20	136.3	48.4	0.506	0.249	2.82	2.03

5.6 Slot Averaged Calculation Method

The slot-averaged values for the every measured signal type were calculated using observed duty cycles.

5.7 Sub-grid Exclusion

The measurement grid defined in C63.19 consists of 9 evenly sized blocks, which are used to define permissible exclusion areas. For both E- and H-field measurements three contiguous blocks may be excluded from the measurements except center block may never be excluded. There must be 4 blocks left that are common for both E- and H-field measurements, so maximum of 5 different blocks can be excluded (e.g. 3 blocks excluded from E-field and 2 blocks from H-field).

5.8 Category Limits

From remaining maximum values after exclusion process, Hearing Aid M-category is defined according to the category limits of C63.19 - 2006.

Category	AWF [dB]	Limits for RF-parameters <960MHz				Limits for RF-parameters >960MHz			
		E-field [V/m]		H-field [A/m]		E-field [V/m]		H-field [A/m]	
		Min	Max	Min	Max	Min	Max	Min	Max
M1	0	631.0	1122.0	1.91	3.39	199.5	354.8	0.6	1.07
M1	-5	473	841.4	1.43	2.54	149.6	266.1	0.45	0.8
M2	0	354.8	631.0	1.07	1.91	112.2	199.5	0.34	0.6
M2	-5	266.1	473.2	0.80	1.43	84.1	149.6	0.25	0.45
M3	**0**	**199.5**	**354.8**	**0.60**	**1.07**	**63.1**	**112.2**	**0.19**	**0.34**
M3	**-5**	**149.6**	**266.1**	**0.45**	**0.80**	**47.3**	**84.1**	**0.14**	**0.25**
M4	0		<199.5		<0.60		<63.1		<0.19
M4	-5		<149.6		<0.45		<47.3		<0.14

6. MEASUREMENT UNCERTAINTY

Source of Uncertainty	Tolerance ±%	Probability Distribution	Div.	ci E	ci H	Standard Uncertainty ±%, E	Standard Uncertainty ±%, H	Remark
MEASUREMENT SYSTEM								
Probe Calibration	5.1	N	1	1	1	5.1	5.1	
Axial Isotropy	4.7	R	√3	1	1	2.7	2.7	
Sensor Displacement	16.5	R	√3	1	0.145	9.5	1.4	
Boundary Effect	2.4	R	√3	1	1	1.4	1.4	
Linearity	4.7	R	√3	1	1	2.7	2.7	SAR
Scaling to Peak Envelope Power	2.0	R	√3	1	1	1.2	1.2	
System Detection Limit	1.0	R	√3	1	1	0.6	0.6	
Readout Electronics	0.3	N	1	1	1	0.3	0.3	SAR
Response Time	0.8	R	√3	1	1	0.5	0.5	
Integration Time	2.6	R	√3	1	1	1.5	1.5	SAR
RF Ambient Conditions	3.0	R	√3	1	1	1.7	1.7	SAR
RF Reflections	12.0	R	√3	1	1	6.9	6.9	
Probe Positioner	1.2	R	√3	1	0.67	0.7	0.5	
Probe Positioning	4.7	R	√3	1	0.67	2.7	1.8	
Extrapolation and Interpolation	1.0	R	√3	1	1	0.6	0.6	SAR
TEST SAMPLE RELATED								
Device Positioning Vertical	4.7	R	√3	1	0.67	2.7	1.8	
Device Positioning Lateral	1.0	R	√3	1	1	0.6	0.6	
Device Holder and Test Arch	2.4	R	√3	1	1	1.4	1.4	
Power Drift	5.0	R	√3	1	1	2.9	2.9	SAR
TEST ARCH AND SETUP RELATED								
Test Arch Thickness	2.4	R	√3	1	0.67	1.4	0.9	
COMBINED STANDARD UNCERTAINTY						**14.7**	**10.9**	
Expanded Uncertainty on Power						**29.4**	**21.8**	
Expanded Uncertainty on Field						**14.7**	**10.9**	

7. RESULTS

The calculated maximum field values for the test device are tabulated below:

GSM850, E and H RF emissions results

Mode	Flip option	Test configuration	Ch 128 824.2MHz	Ch 190 836.6MHz	Ch 251 848.8MHz
GSM850	Flip open	E-field [V/M]	218.3	221.1	**225.3**
		H-field [A/m]	0.404	0.405	**0.420**
		Category	M3 (-5dB)	M3 (-5dB)	M3 (-5dB)

GSM1900, E and H RF emissions results

Mode	Flip option	Test configuration	Ch 512 1850.2MHz	Ch 661 1880.0MHz	Ch 810 1909.8MHz
GSM1900	Flip open	E-field [V/M]	51.7	55.1	**61.0**
		H-field [A/m]	0.108	0.130	**0.147**
		Category	M3 (-5dB)	M3 (-5dB)	M3 (-5dB)

Plots of the measurement scans are shown in **Appendix B.** Excluded cells are colored orange.